1. Introduction

Continuously welded rail (CWR) tracks were introduced to replace rails with fishplated joints as in the latter case the mechanical joints were relatively weak, the geometrical connections were not sufficiently precise and maintenance was very expensive. However, widespread use of CWR tracks has resulted in other problems. Because of the welded joints the track can be considered continuous over an extremely long section. Since the rail is fastened to the sleepers, it is unable to alter its length or only to a very limited extent, so changes in temperature lead to considerable stresses in the rail. Critical increase in these stresses may well lead to buckling or breakage of the rail thereby resulting in a catastrophe, and the repairs are very expensive.

In order to have secure railway traffic it is indispensable to be aware of the exact temperature value at which the stress inside the rail equals zero. This temperature value is called 'stress-free temperature (SFT)' and is considered as the main characteristics of CWR tracks. Cutting and re-welding the rail is a way of determining SFT. This procedure is also called ‘de-stressing SFT’ that is known as a rather expensive method. Therefore, railway companies are steadily looking for cost-saving methods to determine SFT with reliable results.

A few years ago the authors developed a device and method called RailScan to determine SFT by the means of Magnetic Barkhausen Noise (MBN). This device is applied by a great number of railway companies [1].

In this article authors will discuss the effects of remanent magnetic field inside the rail on the determination of MBN. Authors will also present their patented method [2] to increase accuracy of measurement through dynamically eliminating adverse effects of remanent magnetic field.

2. Stress examination using Barkhausen noise measurement

While creating the hysteresis curve, MBN is being produced due to the fact that, under constant changes in the magnetic field, the procedure of getting magnetized is rather running in several tiny little discrete jumps and not in a continuous way. The amplitude, periodicity and dependency on the magnetizing field’s size regarding each step are determined by the structure of ferromagnetic material and the mechanical stress inside the given material volume as well.

The MBN values are in due proportion to mechanical stress values if the material structure is known.

Exact stress values are assessed out of MBN values by the means of calibration curve. The calibration curve is determined by some MBN values taken on a test piece in different stress levels (the test piece is of the same type than the piece to be examined) [3].

3. Determination of MBN values on rails

When determining MBN values on rails, one has to count with a couple of interfering factors that may distort measurement results and accordingly, worse reliability:

- residual stress created during manufacturing,
- remanent magnetic field,
- surface corrosion,
- material structure.

Calibration procedure is done on a piece of rail with the same characteristics than the rail to be examined. While doing so defects originating from residual stress created during manufacturing, surface corrosion, material composition can be eliminated. Calibration is also possible under laboratory circumstances,
either taking a piece of rail cut out or even in the track itself provided its stress values are available.

Remanent magnetization values of rails in track changes from site to site, from time to time, according to
- technology of manufacturing,
- application of magnetic crane,
- Earth's magnetic field,
- railroad traffic intensity,
- rail wear.

The magnetic characteristics of the piece of rail cut out for calibration purposes will change. However, it might undergo a demagnetisation process, but it is practically impossible in case of a railway section.

The method developed by the authors is able to eliminate the effects of remanent magnetic field on MBN values during the measurement.

4. Effects of remanent magnetic field on MBN values

Authors received highest MBN values on rails after several measurement actions only when remanent magnetization values were equal to zero. In other words: the higher the remanent magnetization values, the lower the MBN values.

Explanation of the phenomena: applied excitation cannot cope with magnetization of the material as a whole in opposite direction to the remanent magnetization as well as material is moved by remanent magnetization towards total magnetic saturations, the material’s MBN intensity, however, falls within this range.

5. Compensating remanent magnetic field

The essential point of the method developed by the authors is that in the course of determining MBN values, the so-called ‘MBN group of signals’ that emerge due to periodic excitation, will separately be examined, i.e. both in rising and in falling excitation field sections.

The MBN group of signals created due to rising and falling excitation experience distortion while in remanent magnetization.

After establishing a compensating magnetic field, effects of remanent magnetization can be eliminated in the given volume of material.

The MBN group of signals coming from rising and falling excitation are under permanent control of the electronics technology released by the authors. Size of compensating magnetic field will automatically be adjusted until both group of signals become free of any distortions. In this way electronics guarantee optimal MBN results that always equal the maximum of MBN values at the given point.

Remanent magnetization and direction of excitation do not necessarily coincide with each other. Authors state that using excitations offset by 90 degrees relative to each other it is possible to find a certain compensating magnetic field that ensures maximum of MBN values by means of adequate combination of the two excitations. Compensation is only active in the volume to be measured and only during measurement action, i.e. energy consumption is consequently less than having the whole rail magnetized.

6. Summary

Authors succeeded in developing a suitable method and device to compensate adverse effects of remanent magnetization in the course of determining MBN values, under field conditions and with minimal energy consumption.

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8. References